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REPORT TO THE ADVISORY COMMITTEE ON REVISION OF
THE PUBLIC HEALTH SERVICE 1946 DRINKING WATER
STANDARDS

Public Health Service
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PUBLIC HEALTH SERVICE 1946 DRINKING WATER STANDARDS

May 3, 1961

U.S. Department of Health, Education and Welfare
Public Health Service
Division of Water Supply and Pollution Control

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PREFACE

Domestic water supplies should protect the health and promote the well-being of individuals and the community. In this report on the revision of the 1946 edition of the Public Health Service Drinking Water Standards, the objective of the Committee is to recommend minimum requirements for reaching this goal.

The Public Health Service Drinking Water Standards were first adopted in 1914 to protect the health of the traveling public. The general and widespread use of these Standards since that time has led to a series of revisions which have been applicable to water supplies generally. The development of atomic energy and other technological advances requires that these Standards again be revised. To carry out this revision, the Chief Sanitary Engineer of the Public Health Service appointed the undersigned Advisory Committee. A Technical Subcommittee of Public Health Service Officers and a Toxicological Task Force were established to collect information and prepare suggestions for the consideration of the Advisory Committee.

In preparing this report on the revision of the Standards, the Committee established the following guidelines:

1. The proposed standards should be discussed widely and due cognizance should be given to International and other standards of water quality before a final report is submitted.
2. A new section on radioactivity should be added.
3. Greater attention should be given to the chemical substances being encountered increasingly in both variety and quantity in water sources.
4. In establishing limits for toxic substances, intake from food and air should be considered.
5. The rationale employed in determining the various limits should be included in an appendix.
6. The proposed format, with the exceptions noted above, should not differ greatly from the present Standards.
7. The Standards should be generally acceptable and should be applicable to all public water supplies in the U. S., as well as those supplies used by carriers subject to the Public Health Service regulations.

8. The following two types of limits used in previous editions should be continued:

- a. Limits which, if exceeded, shall be grounds for rejection of the supply. Substances in this category may have adverse effects on health when present in concentrations above the limit.
- b. Limits which should not be exceeded whenever more suitable supplies are, or can be made, available at reasonable cost. Substances in this category, when present in concentrations above the limit, are either objectionable to an appreciable number of people or exceed the levels required by good water quality control practices.

9. These limits should apply to the water at the free-flowing outlet of the ultimate consumer.

This revision of the Drinking Water Standards includes, for the first time, limiting concentrations of radioactivity in water. The effects on large population groups of chronic exposure to low levels of radioactivity are not yet well defined. The limits presented herein are an effort to derive conservative values from the best information now available and may be adjusted upward or downward as new and better data become available.

The Committee has taken cognizance of the growing problem of potentially harmful chemicals in sources of drinking water. Limits for several new chemicals have been added, including a gross limit for the concentration of some types of synthetic chemicals. It was not feasible, however, to include limits for all the many chemicals that have varying degrees of toxic potential. Consideration was given to the more common chlorinated hydrocarbon and organophosphate insecticides but the information available was not sufficient to establish specific limits for these chemicals. Moreover, the concentrations of these chemicals, where tested, have been below those which would constitute a known health hazard. The Committee believes that pollution of water supplies with such contaminants can become significant and urges that the problem be kept under closer surveillance. Further, the Committee recommends that regulatory actions be taken to minimize concentrations of such chemicals in drinking water.

In view of the accelerating pace of new developments affecting water quality, the Committee recommends that a mechanism be established for continual appraisal and appropriate

revision of the Standards. It also recommends that the Public Health Service intensify its continuing studies toward the development of basic information on the relationship of the biological, chemical, physical, and radiological aspects of water quality to health.

1. DEFINITION OF TERMS

The terms used in these Standards are as follows:

1.1 Adequate protection by natural means involves one or more of the following processes of nature that produces water consistently meeting the requirements of these Standards: dilution, storage, sedimentation, sunlight, aeration, and the associated physical and biological processes which tend to accomplish natural purification in surface waters and, in the case of ground waters, the natural purification of water by infiltration through soil and percolation through underlying material and storage below the ground water table.

1.2 Adequate protection by treatment is any one or any combination of the controlled processes of coagulation, sedimentation, sorption, filtration, disinfection, or other processes which produce a water consistently meeting the requirements of these Standards. This protection also includes processes which are appropriate to the source of supply; works which are of adequate capacity to meet maximum demands without creating health hazards, and which are located, designed, and constructed to eliminate or prevent pollution; and conscientious operation by well-trained and competent personnel whose qualifications are commensurate with the responsibilities of the position and acceptable to the Reporting Agency and the Certifying Authority.

1.3 Certifying Authority is the Surgeon General of the United States Public Health Service or his duly authorized representatives. (Reference to the Certifying Authority is applicable only for those water supplies to be certified for use on carriers subject to the Public Health Service Regulations--42 CFR Part 72).

1.4 The coliform group includes all organisms considered in the coliform group as set forth in Standard Methods for the Examination of Water and Wastewater, current edition, prepared and published jointly by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation.

1.5 Health hazards are conditions, devices, or practices in the water supply system and its operation which create, or may create, a danger to the health and well-being of the water consumer. An example of a health hazard is a structural defect in the water supply system, whether of location, design, or construction, which may regularly or occasionally prevent satisfactory purification of the water supply or cause it to be polluted from extraneous sources.

1.6 Pollution, as used in these Standards, is defined as the presence of any foreign substance (organic, inorganic, radiological, or biological) in water which tends to degrade its quality so as to constitute a hazard or impair the usefulness of the water.

1.7 Reporting Agencies are the respective official State health agencies or their designated representatives.

1.8 The standard sample for the bacteriological test shall consist of:

1.81 For the bacteriological fermentation tube test, five (5) standard portions of either:

- (a) ten milliliters (10 ml)
- (b) one hundred milliliters (100 ml)

1.82 For the membrane filter technique, not less than fifty milliliters (50 ml).

1.9 Water supply system includes the works and auxiliaries for collection, treatment, storage, and distribution of the water from the sources of supply to the free-flowing outlet of the ultimate consumer.

2. SOURCE AND PROTECTION

2.1 The water supply should be obtained from the most desirable source which is feasible, and effort should be made to prevent or control pollution of the source. If the source is not adequately protected by natural means, the supply shall be adequately protected by treatment.

2.2 Frequent sanitary surveys shall be made of the water supply system to locate and identify health hazards which might exist in the system. The manner and frequency of making these surveys, and the rate at which discovered health hazards are to be removed, shall be in accordance with a program approved by the Reporting Agency and the Certifying Authority.

2.3 Approval of water supplies shall be dependent in part upon:

- (a) Enforcement of rules and regulations to prevent development of health hazards;
- (b) Adequate protection of the water quality throughout all parts of the system, as demonstrated by frequent surveys;

- (c) Proper operation of the water supply system under the responsible charge of personnel whose qualifications are acceptable to the Reporting Agency and the Certifying Authority;
- (d) Adequate capacity to meet peak demands without development of low pressures or other health hazards; and
- (e) Record of laboratory examinations showing consistent compliance with the water quality requirements of these Standards.

2.4 For the purpose of application of these Standards, responsibility for the conditions in the water supply system shall be considered to be held by:

- (a) The water purveyor from the source of supply to the connection to the customer's service piping; and
- (b) The owner of the property served and the municipal, county, or other authority having legal jurisdiction from the point of connection to the customer's service piping to the free-flowing outlet of the ultimate consumer.

3. BACTERIOLOGICAL QUALITY

3.1 SAMPLING.

3.11 Compliance with the bacteriological requirements of these Standards shall be based on examinations of samples collected at representative points throughout the distribution system. The frequency of sampling and the location of sampling points shall be established jointly by the Reporting Agency and the Certifying Authority after investigation by either agency, or both, of the source, method of treatment, and protection of the water concerned.

3.12 The minimum number of samples to be collected from the distribution system and examined each month should be in accordance with the number on the graph in Figure I, for the population served by the system. For the purpose of uniformity and simplicity in application, the number determined from the graph should be in accordance with the following: for a population of 25,000 and under--to the nearest 1; 25,001 to 100,000--to the nearest 5; and over 100,000--to the nearest 10.

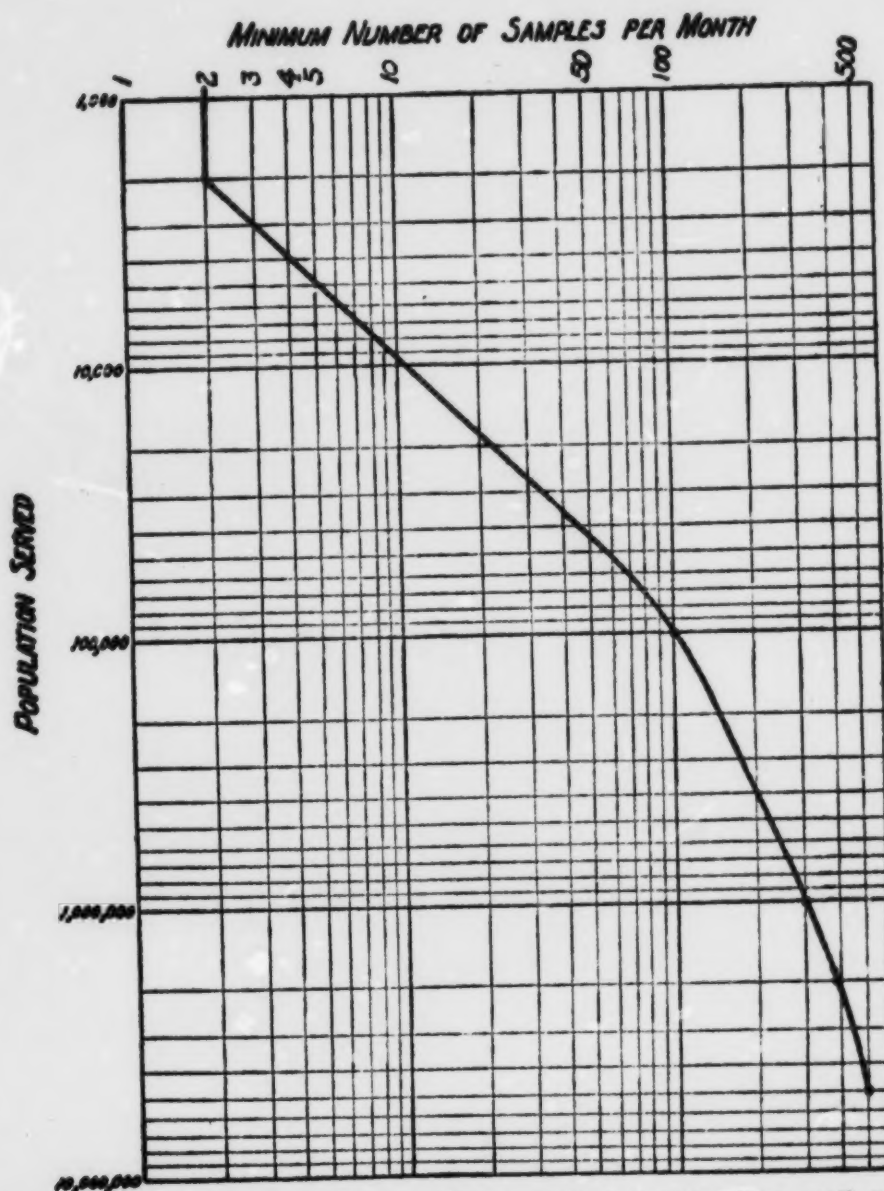


FIGURE 1—Relation between minimum number of samples to be collected per month and population served.

3.13 In determining the number of samples examined monthly, the following samples may be included, provided all results are assembled and available for inspection and the laboratory methods and technical competence of the laboratory personnel are approved by the Reporting Agency and the Certifying Authority:

- (a) Samples examined by the Reporting Agency;
- (b) Samples examined by local government laboratories;
- (c) Samples examined by the water works authority;
- (d) Samples examined by commercial laboratories.

3.14 The laboratories in which these examinations are made and the methods used in making them shall be subject to inspection at any time by the designated representatives of the Certifying Authority and the Reporting Agency. Compliance with the specified procedures and the results obtained shall be used as a basis for certification of the supply.

3.15 Daily samples collected following a bacteriologically unsatisfactory sample as provided in Sections 3.21, 3.22, and 3.23 shall be considered as special samples and shall not be included in the total number of samples examined. Neither shall such special samples be used as a basis for prohibiting the supply, provided that: (1) When waters of unknown quality are being examined, simultaneous tests are made on multiple portions of a geometric series to determine a definitive coliform content; (2) Immediate and active efforts are made to locate the cause of pollution; (3) Immediate action is taken to eliminate the cause; and (4) Samples taken following such remedial action are satisfactory.

3.2 LIMITS. The presence of organisms of the coliform group as indicated by samples examined shall not exceed the following limits:

3.21 When 10 ml standard portions are examined, not more than 10 percent in any month shall show the presence of the coliform group. The presence of the coliform group in three or more 10 ml portions of a standard sample shall not be allowable if this occurs:

- (a) In two consecutive samples;
- (b) In more than one sample per month when less than 20 are examined per month; or
- (c) In more than five percent of the samples when 20 or more are examined per month.

When organisms of the coliform group occur in three or more of the 10 ml portions of a single standard sample, daily samples from the same sampling point shall be collected promptly and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality.

3.22 When 100 ml standard portions are examined, not more than 60 percent in any month shall show the presence of the coliform group. The presence of the coliform group in all five of the 100 ml portions of a standard sample shall not be allowable if this occurs:

- (a) In two consecutive samples;
- (b) In more than one sample per month when less than five are examined per month; or
- (c) In more than 20 percent of the samples when five or more are examined per month.

When organisms of the coliform group occur in all five of the 100 ml portions of a single standard sample, daily samples from the same sampling point shall be collected promptly and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality.

3.23 When the membrane filter technique is used, the arithmetic mean coliform density of all standard samples examined per month shall not exceed one per 100 ml. Coliform colonies per standard sample shall not exceed 3/50 ml, 4/100 ml, 7/200 ml, or 13/500 ml in:

- (a) Two consecutive samples;
- (b) More than one standard sample when less than 20 are examined per month; or
- (c) More than five percent of the standard samples when 20 or more are examined per month.

When coliform colonies in a single standard sample exceed the above values, daily samples from the same sampling point shall be collected promptly and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality.

4. PHYSICAL CHARACTERISTICS

4.1 SAMPLING. The frequency and manner of sampling shall be determined by the Reporting Agency and the Certifying Authority. Under normal circumstances samples should be collected one or more times per week from representative points in the distribution system and examined for turbidity, color, threshold odor, and taste.

4.2 LIMITS. Drinking water should contain no impurity which would cause offense to the sense of sight, taste, or smell. Under general use, the following limits should not be exceeded:

Turbidity	- 5 units
Color	- 15 units
Threshold Odor Number	- 3

5. CHEMICAL CHARACTERISTICS

5.1 SAMPLING. The frequency and manner of sampling shall be determined by the Reporting Agency and the Certifying Authority. Under normal circumstances, analyses for substances listed below need be made only semi-annually. If, however, there is some presumption of unfitness because of the presence of undesirable elements, compounds, or materials, periodic determinations for the suspected toxicant or material should be made more frequently and an exhaustive sanitary survey should be made to determine the source of the pollution. Where the concentration of a substance is not expected to increase in processing and distribution, available and acceptable source water analyses performed in accordance with standard methods may be used as evidence of compliance with these Standards.

Where experience, examination, and available evidence indicate that particular substances are consistently absent from a water supply or below levels of concern, semi-annual examinations for those substances may be omitted when approved by the Reporting Agency and the Certifying Authority.

The burden of analysis may be reduced in many cases by using data from acceptable sources. Judgment concerning the quality of water supply and the need for performing specific local analyses may depend in part on information produced by such agencies as: (1) The U. S. Geological Survey, which determines chemical quality of surface and ground waters of the United States and publishes these data in "Water Supply Papers" and other reports, and (2) The U. S. Public Health Service which determines water quality related to pollution (or the absence of pollution) in the principal rivers of the Nation

and publishes these data annually in "National Water Quality Network". Data on pollution of waters as measured by carbon chloroform extracts (CCE) may be found in the latter publication.

5.2 LIMITS. Drinking water shall not contain impurities in concentrations which may be hazardous to the health of the consumers. It should not be excessively corrosive to the water supply system. Substances used in its treatment shall not remain in the water in concentrations greater than required by good practice. Substances which may have deleterious physiological effect, or for which physiological effects are not known, shall not be introduced into the system in a manner which would permit them to reach the consumer.

5.21 The following chemical substances should not be present in a water supply in excess of the listed concentrations where, in the judgment of the Reporting Agency and the Certifying Authority, other more suitable supplies are or can be made available.

<u>Substance</u>	<u>Concentration in mg/l</u>
Alkyl Benzene Sulfonate (ABS)	0.5
Arsenic (As)	0.01
Chloride (Cl)	250.0
Copper (Cu)	1.0
Carbon Chloroform Extract (CCE)	0.2
Cyanide (CN)	0.01
Fluoride (F)	(See 5.23)
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitrate* (NO ₃)	45.0
Phenols	0.001
Sulfate (SO ₄)	250.0

* In areas in which the nitrate content of water is known to be in excess of the listed concentration, the public should be warned of the potential dangers of using the water for infant feeding.

<u>Substance</u>	<u>Concentration in mg/l</u>
Total Dissolved Solids	500.0
Zinc (Zn)	5.0

5.22 The presence of the following substances in excess of the concentrations listed shall constitute grounds for rejection of the supply:

<u>Substance</u>	<u>Concentration in mg/l</u>
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	0.01
Chromium (Cr ⁺⁶)	0.05
Cyanide (CN)	0.2
Fluoride (F)	(See 5.23)
Lead (Pb)	0.05
Selenium (Se)	0.01
Silver (Ag)	0.05

5.23 FLUORIDE. When fluoride is naturally present in drinking water, the concentration should not average more than the appropriate upper limit in Table I. Presence of fluoride in average concentrations greater than two times the optimum values in Table I shall constitute grounds for rejection of the supply.

Where fluoridation (supplementation of fluoride in drinking water) is practiced, the average fluoride concentration shall be kept within the upper and lower control limits in Table I.

Table I

Annual Average of Maximum Daily Air Temperatures <u>a/</u>	RECOMMENDED CONTROL LIMITS Fluoride Concentrations in mg/l		
	Lower	Optimum	Upper
50.0 - 53.7	0.9	1.2	1.7
53.8 - 58.3	0.8	1.1	1.5
58.4 - 63.8	0.8	1.0	1.3
63.9 - 70.6	0.7	0.9	1.2
70.7 - 79.2	0.7	0.8	1.0
79.3 - 90.5	0.6	0.7	0.8

a/ Based on temperature data obtained for a minimum of five years

In addition to the sampling required by paragraph 5.1 above, fluoridated and defluoridated supplies shall be sampled with sufficient frequency to determine that the desired fluoride concentration is maintained.

6. RADIOACTIVITY

6.1 SAMPLING. The frequency of sampling and analysis for radioactivity shall be determined by the Reporting Agency and the Certifying Authority after consideration of the likelihood of significant amounts being present. Where concentrations of Ra^{226} or Sr^{90} may vary considerably, quarterly samples composited over a period of three months are recommended. Samples for determination of gross activity should be taken and analyzed more frequently.

As indicated in paragraph 5.1, data from acceptable sources may be used to indicate compliance with these requirements.

6.2 LIMITS. The effects of human radiation exposure are viewed as harmful and any unnecessary exposure to ionizing radiation should be avoided. The concentrations of radioactivity specified below for drinking water are intended to limit intake of these substances by this route so that total radiation exposure of population groups does not exceed appropriate Radiation Protection Guides recommended by the Federal Radiation Council. Concentrations which exceed, on the average, the values presented

below for a period of one year shall constitute grounds for rejection of the supply. Where the total intake of Ra²²⁶ and Sr⁹⁰ from all sources has been determined, these limits may be adjusted by the Reporting Agency and the Certifying Authority so that the total intake of Ra²²⁶ and Sr⁹⁰ will not exceed 7.3 uuc per day and 73 uuc per day respectively.

<u>Radionuclides</u>	<u>Concentrations in uuc/liter</u>
Radium ²²⁶	3
Strontium ⁹⁰	10
Gross Beta Activity (Strontium ⁹⁰ and alpha emitters absent*)	1000

6.21 When mixtures of Radium²²⁶, Strontium⁹⁰, and other radionuclides are present, the above limiting values shall be modified to assure that the combined intake is not likely to result in radiation exposure in excess of the Radiation Protection Guides recommended by the Federal Radiation Council.

7. RECOMMENDED ANALYTICAL METHODS

7.1 Analytical methods to determine compliance with the requirements of these Standards shall be those specified in Standard Methods for the Examination of Water and Wastewater, Am. Pub. Health Assoc., current edition and those specified as follows.

7.2 Barium--Methods for the Collection and Analysis of Water Samples, Water Supply Paper No. 1454, Rainwater, F. H. and Thatcher, L. L., U. S. Geological Survey, Washington, D. C.

7.3 Carbon Chloroform Extract (CCE)--Manual for Recovery and Identification of Organic Chemicals in Water, Middleton, F. M., Rosen, A. A., and Burttschell, R. H., Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati, Ohio.

7.4 Radioactivity--Laboratory Manual of Methodology, Radionuclide Analysis of Environmental Samples, Technical Report R59-6, Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati, Ohio; and Methods of Radiochemical Analysis,

* Absent is taken here to mean a negligibly small fraction of the above specific limits, where the limit for unidentified alpha emitters is taken as the listed limit for Ra²²⁶.

Technical Report No. 173, Report of the Joint WHO-FAO Committee, 1959, World Health Organization.

7.5 Selenium--Suggested Modified Method for Colorimetric Determination of Selenium in Natural Water, Magin, G. B., Thatcher, L. L., Rettig, S., and Levine, H., J. Am. Water Works Assoc. 52, 1199 (1960).

7.6 Organisms of the coliform group--All of the details of techniques in the determination of bacteria of this group, including the selection and preparation of apparatus and media, the collection and handling of samples and the intervals and conditions of storage allowable between collection and examination of the water sample, shall be in accordance with Standard Methods for the Examination of Water and Wastewater, current edition, and the procedures shall be those specified therein for:

7.61 The Membrane Filter Technique, Standard Test,
or

7.62 The Completed Test, or

7.63 The Confirmed Test, procedure with brilliant
green lactose bile broth*, or

7.64 The Confirmed Test, procedure with Endo or
eosin methylene blue agar plates*

* The Confirmed Test is allowed, provided the value of this test to determine the sanitary quality of the specific water supply being examined is established beyond reasonable doubt by comparisons with Completed Tests performed on the same water supply.

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